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**CONFLICT, INTERFERENCE AND AGGRESSION:
COMPUTER SIMULATION OF A SOCIAL PROCESS**

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TABLE OF CONTENTS

	<u>Page</u>
Introduction	1
Advantages of Computers.	4
Previous Simulation Studies.	5
Concept of Aggression.	7
Dyadic Relationship.	8
The Simulation Program	15
Results of Trial Runs.	20
Low Tolerance for Frustration.	21
High and Low Tolerance for Frustration	24
Conclusion	26
References	28

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Introduction

For many years now social scientists have been studying human interaction using every available means at their command; from direct observation of one's own children, like Charles Cooley, to complex and elaborately constructed laboratory experiments. Recent technological innovations have now made available still another instrument for examining human behavior: the high-speed, electronic computer. For the most part, social scientists have been slow to make use of this tool, but this situation is rapidly changing (Vandenberg, et. al., 1962). The purpose of this paper is to report the results of an initial experiment in simulating human behavior with the IBM 650 computer.

Since not every social scientist and probably few humanists view the advent of simulation with an unjaundiced eye, it may be well to begin with their position. In an article entitled, "Hamlet's Low-Speed Computer," The Saturday Review (April 7, 1962)

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presented an edited conversation between Elting E. Morison, Professor of Industrial History, and Norbert Wiener, Professor of Mathematics, both of the Massachusetts Institute of Technology. The gist of Morison's comments was that scientists are asking the wrong questions of the right mechanical apparatus. He goes on to say there is

...the persistent human temptation to make life more explicable by making it more calculable; to put experience into some logical scheme that, by its order and niceness, will make what happens seem more understandable, analysis more bearable, decision simpler (Sat. Rev., 1962, p. 46).

Although Morison admits that the attempt to work with quantified elements and logical systems is in accord with the aims of science, he feels there is a danger of losing the significance of qualitative elements of affections, feelings, etc. He suggests, therefore, that we ask not the problem-solving type of questions as has been done in the past, but rather "learning" type questions that present answers based on past experience and evidence. For example, one should ask the computer to successfully relocate a factory, or find the common elements in a revolution or devise a program for aiding underdeveloped countries undergoing the impact of modern technology (Sat. Rev., 1962, p. 47).

Professor Wiener's counterargument was that these goals lie in the future, but in the near future. Learning type programs are already in existence, for example, playing checkers in which the machine records all its past moves and it "learns" not to repeat those moves which result in losing a checker to its human

opponent. The problem with learning programs is that man is not able to control them completely. Unlike calculation programs which give out only a re-arranged sequence of numbers or values originally put in, learning programs may not give out answers to the questions asked unless restrictions of unwanted results are written into the program. In other words, in order to maintain control over the output of the machine, man must still put restrictions on the internal processes of the machine and this is delaying the development of programs which can handle the problems suggested by Professor Morison. The criticism being made here can be summarized as follows: there are two main limitations in simulating human behavior; machine and human. Machine limitations are relatively simple, such as inadequate storage space for symbols (which is being overcome). In addition, however, the machine is an automaton--it can do only exactly as it is told and no more--and this reflects the human limitation. Simulation programs can only be as good as the man who writes them. At the present time, the complexity of social relationships and the social scientist's knowledge about them places a very real limit on the sophistication of the programs he can write.

Advantages of Computers

If it can be said, however, that we are willing to work toward the goal of highly sophisticated, learning type programs in small steps, then the many advantages of simulation can be utilized. For example, one of the ever-present problems in social science research is control of variables. Simulation permits the examination of two-variable or even multi-variable relationships with the effects of confounding variables removed. Unfortunately, as in contemporary field research, the effects of only those variables "known" to the researcher to be related to the variables under consideration can be removed. Similarly, simulation permits rigor and precision through simulated measurement seldom found in field research. This, in turn, allows the researcher to examine in minute detail complex relationships, which under ordinary field conditions may not be separable. Furthermore, simulation programs are perfectly reliable in the sense that they produce exactly the same results every time. Finally, there is the considerable advantage of speed and accuracy. Simulated programs can produce results in a small fraction of the time that would be required for more conventional field research and except for mechanical malfunctioning, the computer never makes a mistake (unless introduced by the human operator).

Previous Simulation Studies

In the small, but growing literature, one can find, besides technical articles such as those by Harling (1958) and Conway, et.al., (1959), studies of physical processes, production and inventory, traffic control, maintenance of payroll systems, etc. There are, however, relatively few good examples of simulation in the social sciences. One exception is the recent publication by Orcutt and associates (1961), which examines the modern American economy by simulating the consumption patterns of a representative "sample" of the American population. It is interesting to note the effective use of demographic data such as births, deaths, marriages and geographical and social mobility of the simulated population (Greenberger, 1960).

In the field of psychology there are programs for the simulation of human thinking. One program, reported by Newell and Simon (1959), consists of several integrated programs representing current theory of human thinking. The total program is designed to simulate certain salient characteristics of human problem-solving which at the same time, permits a rigorous and detailed examination of a significant area of human symbolic behavior. Another program, on cognitive organization, has been reported by Gyr, et.al., (1962).

In sociological research, simulation has been primarily in the area of voting behavior (McPhee and Smith, 1958; Coleman and Waldorf, 1959). A paper by MCPhee and Smith is particularly interesting in light of the criticisms made earlier. The model

presented by McPhee and Smith is indeed a learning type model. It is composed of three separate processes which represent the "real" processes found in previous field research (Lazarsfeld, et.al., 1944; Berelson, et.al., 1954; Campbell, 1954; Campbell, et.al., 1960). First, there is the response to external political stimuli represented by certain characteristics such as degree of political interest, current party choice, probability of partisanship, socio-economic standing and these same characteristics of friends, spouse or parents which are used to modify the interests and voting intentions of the voter. This modification takes place in the second process, that of the mutual influence of individuals within the immediate social environment, that is, the influence of family and friends on each other. Finally, the third process is one of "learning" over time. Learning is not used in the ordinary sense as in psychology, but rather it is the process by which the habit of partisanship is acquired. With the IBM 650, this program can provide simulated data on a sample of 200 voters who can be stratified in any way the researcher desires. One can only speculate on the usefulness of this program in predicting the outcome of elections when further demographic and social structural parameters are known.

Concept of Aggression

Before reporting the details and results of this simulation program, it would be appropriate to first describe the conceptualization of aggression used here as well as some assumptions made about the behavior of persons in a dyadic relationship. The concept of aggression used in this paper is based on the investigations of Hamblin (1962a). After a critical review of the literature and considerable experimentation with small groups, he concluded that for the majority of persons, aggression is an operant activity, the goal-response of which is compliance or acquiescence of the agent or agent-surrogate of frustration. In other words, based on the evidence in several experiments (Thibaut and Riecken, 1955; Day and Hamblin, 1961; Wilkins and deCharms, 1961), it was found that about 80% of the time, Ss used aggressive behavior in an instrumental manner to make the agent of frustration comply with the S's wishes (or expectations). Approximately 20% of the time, these Ss engaged in "retaliatory" aggression, i.e., seeking revenge (Dollard, et.al., 1939). For this simulation program, then aggression is defined as any activity intentionally designed to injure the agent or agent-surrogate of frustration and result in the acquiescence or compliance of the agent.

Dyadic Relationship

In describing the interaction that takes place between two persons, here labeled Ego and Alter, it is necessary to first make explicit the assumptions upon which this description is based (Simmel, 1950; Heider, 1958; Thibaut and Kelley, 1959; Homans, 1961). First, it is assumed that Ego and Alter are known to each other before the interaction takes place. This does not necessarily mean they are intimate friends, but it does mean they can avoid the machinations about first meetings that are described by Blau (1960). Second, it is assumed that Ego and Alter are in a voluntaristic relationship, that is, either is free to terminate the relationship at any time. Third, they enjoin this relationship for the purpose of achieving the same goal, perceived by each as beneficial to himself. In other words, each sees in the attainment of this goal something of value to himself while potential rewards for the other are incidental. The fourth assumption is that each perceives in himself an inability to achieve the goal through his efforts alone, e.g., cooperation is necessary for the collection of rewards. Fifth, it is assumed that through previous learning, whether from experience or vicariously, each actor has some expectation with respect to outcomes and an appropriate course of action which will lead to the attainment of the goal. Finally, it is assumed that both Ego and Alter are capable of carrying out the mechanical details of their planned course of action.

With the goal in mind, each actor expresses his feeling on the appropriate course of action for them to take based on his expectations, i.e., his prediction of successful outcome of their joint venture. If it happens that their expectations are the same, they would proceed immediately by comparing their intentions (see below). If they are successful in reaching the goal they would be rewarded (their intentions would be reinforced); if they are unsuccessful they would not be rewarded. There are at least two considerations here. First is the fact that their expectations match. This in itself could be rewarding although it says nothing about the outcome of the behavior. Secondly, if they are successful and are rewarded in proportion to their expectations, their expectations would be reinforced to the extent that in a similar future situation, this course of action would be the first one attempted. If the actual rewards did not equal the expected rewards, they would probably still be rewarded, but less strongly (Hamblin, 1962b). As a result, the perceived rewards of this particular goal would probably be revised downward. On the other hand, if they are unsuccessful in attaining the goal, they would not only be not rewarded, but they would, by definition, experience frustration. In this case, negative reinforcement occurs and the probability of the response reoccurring would decrease. It is, of course, possible that Ego might attribute the failure to Alter (or vice versa), but in this case it is considered unlikely since their expectations matched.

If, when expressing their expectations for an appropriate course of action, they find their expectations diverge, they would immediately experience frustration from the delay in working toward the goal. In addition, they would be faced with the task of aligning their intentions (see below) before they could proceed.

This task is similar to a problem-solving process and is so called in this paper. In order to examine this process, it is necessary to first define what are thought to be the relevant variables involved. (1) INTENTION TO ACT--means a mental set or predisposition to exhibit certain behavior. This set is reached through a conscious assessment of the following variables.

(2) PERCEIVED INSTRUMENTALITY--is the degree to which a particular course of action is deemed efficacious in attaining a goal. This, of course, stems directly from the actor's expectations.

(3) PERCEIVED REWARDS--refer to what Ego and Alter each expect to receive from attaining the goal. It does not, in this case, refer to what they expect to get from the relationship, per se.

(4) PERCEIVED COSTS--are what the actors expect to contribute to the relationship in order to reach the goal. Finally,

(5) EXPECTATIONS--are a set of learned beliefs upon which are based an actor's predictions of his role partner's behavior. One way of expressing the relationship in an arbitrary, quasi-mathematical form is

$$\text{INTENTION} = (\text{INSTRUMENTALITY} + (\text{REWARDS-COSTS})) \times \\ \text{EXPECTATIONS TO ACT} \cdot$$

When Ego's intentions are very different from Alter's or vice versa, in effect, when one member has little investment, that member voluntarily capitulates and they can proceed with an attempt at goal attainment without incurring any frustration. If, on the other hand, their intentions are sufficiently the same to delay attainment of the goal, each should experience frustration. Frustration is seen as an additive variable, e.g., a series of frustrating experiences increases the total amount of frustration and a series of successes could decrease it (Hamblin, 1961). In addition, the perceived value of the goal should decrease while the costs to the individual actor should increase. Perhaps, also, when their intentions diverge, each actor "takes a second look" at his approach to reaching the goal, thus decreasing the perceived instrumentality. Taking these modifications into consideration, there would be changes in their intention, that is, each actor's intention could also decrease. Consequently, when they attempted to resolve their differences in intentions, they would be operating under a different set of considerations, e.g., the variables will have changed in value. If the attempt to resolve differences fails, each actor should further experience frustration. If the second or later attempt is successful, however, some of the frustration should be alleviated and there should also be an increase in perceived instrumentality and rewards and a decrease in costs

for each actor. It is felt that attempts to solve their differences in intentions will probably continue until (a) they are successful and can proceed toward the goal, (b) the reward-cost differential becomes zero, that is, the costs of the endeavor are perceived as too great in comparison to perceived rewards, or (c) the level of frustration of one or the other of the actors reaches a point where he engages in aggressive behavior. In either (b) or (c) there are several alternatives which could occur.

When the reward-cost differential becomes zero, the actors could decide on a rational basis that "it just isn't worth the effort" and quit trying (in effect, breaking the relationship for this set of expectations). On the other hand, the more utilitarian aspects of the situation may be ignored, and they may continue to try to solve their differences (with increasing frustration) until the costs become prohibitive or the level of tolerance for frustration is exceeded.

Throughout this paper, reference has been made to "level of frustration" and "level of tolerance for frustration." In the tradition of Dollard and associates (1939), aggression is seen as a necessary consequence of frustration except where there is an expectation of strong punitive sanctions. The latter expectation is excluded from this discussion so that some form of aggression can be anticipated when the individual's tolerance for frustration has been exceeded. Further, it is postulated that the greater the amount of perceived frustration, the

greater will be the amount of aggression exhibited. For the purposes of this paper, aggression is divided into three levels, each with different consequences.

Low level aggression (produced by a low level of frustration) is conceived as mild verbal reprimands, perhaps caustic remarks of one actor towards the other, especially with respect to intentions. For example, even when they agree enough on expectations to attempt to reach the goal, frustration produced by failure to do so may cause the one whose intentions were subordinated to comment unfavorably on the intentions of the one whose intentions were followed, but failed to attain the goal. In any event, this is not regarded as a serious threat to the relationship. About all that occurs is an increase in frustration (greater for the member whose intentions proved to be unsuccessful) and in costs to both actors. Concomitantly, there should be a decrease in instrumentality and rewards for both actors. Under these conditions, they attempt to re-establish their intentions, that is, they again attempt to resolve their differences.

When frustration has reached a level that produces moderate aggression there occur serious verbal assaults such as personal insults, casting aspersions on the capabilities of the other in sensitive areas, perhaps even a mild form of physical abuse or threats of dissolving the relationship or threats of physical abuse. Under these conditions, the victim of the attack capitulates to the aggressor, that is, his intentions are disregarded. In effect, the victim is saying, "okay, okay, we'll do it your way." Now if

the aggressor's intentions lead to goal achievement, he will be disproportionately rewarded while the victim's rewards are less since he gets little credit for having reached the goal, even though it was essentially a cooperative effort. In other words, for the victim of the aggression, although he is rewarded, his costs also increase. If, however, the aggressor's intentions do not result in goal attainment, his frustration is increased more than that of the victim and so are the former's costs. In addition, the victim may terminate the relationship since the aggressor "had his chance and failed to produce."

Finally, under conditions of high aggression, it is felt that whatever form it takes, the form is severe enough to cause the relationship to break down. In this situation, their respective expectations with respect to the goal disappear, analogous to extinction in learning theory. This is in contrast to intentions of the victim becoming inoperative under conditions of moderate aggression. In any event, no further attempt is made by Ego or Alter to resolve their intentions or reach the goal. The case of low level aggression and especially moderate aggression are viewed as rational uses of aggressive behavior, i.e., compliance-seeking behavior. That is, they are not spontaneous reactions to frustration (or the agent of frustration), but rather are premeditated courses of action designed to bring the perceived agent of frustration into line, to exert some control over his partner, or more simply, to "get his way." Since the consequences of high aggression are rather severe,

these statements do not apply. This is more a case of "retaliatory" aggression or "blowing one's top."

Perhaps one last word should be made about reinforcement. This process is seen here as more than just receiving rewards. In addition, costs decrease, since presumably, when the situation arises again, there would be less difficulty in establishing coincident expectations. Furthermore, the perceived instrumentality should increase at least to the extent that their original course of action is rewarded by successful goal achievement.

The Simulation Program

This program, like some of those noted above, consists of the integration of four separate programs representing certain processes. The four processes are (a) establishment and comparison of expectations; (b) attempted goal achievement; (c) reinforcement; and (d) aggression (see Figure 1).

In comparing expectations, randomly generated numbers are drawn from a matrix of paired expectations. These numerical values are tested for differences. If they are equal, that is if there is no difference, the program proceeds to computing intentions. If there is a difference, however, each of the actors is frustrated and each time their frustration is increased, the level of frustration is tested against the level of tolerance for frustration. If the former exceeds the latter, the program shifts into the aggression process (see below); otherwise there is a further test to determine if the reward-cost differential

Read & store values of reward, cost, relative power, expectations, perceived instrumentality, tolerance for frustration, etc.

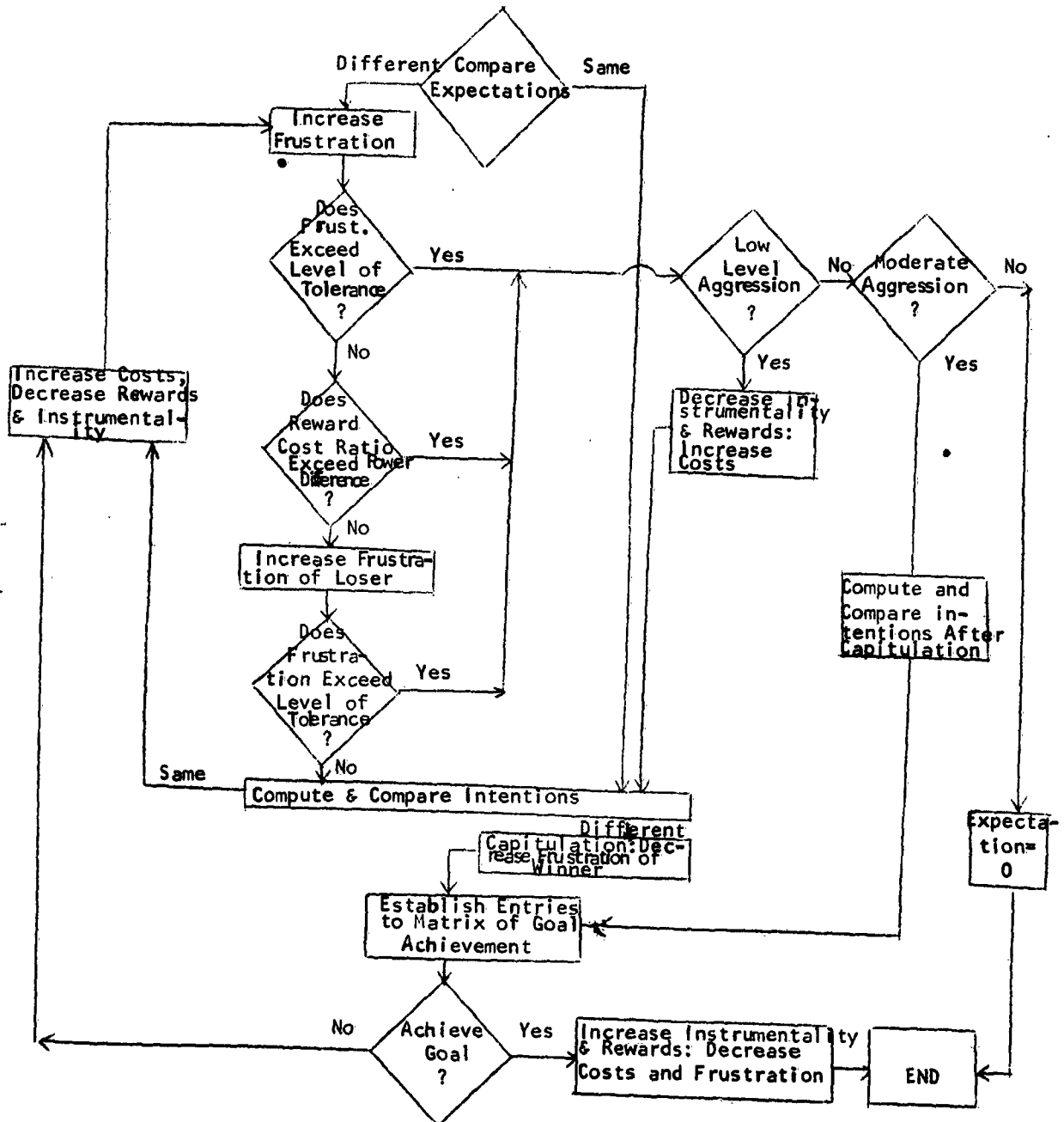


FIGURE 1. FLOW CHART

of each actor exceeds the power differential of the other.

In this paper, power is a relative variable, i.e., the ability of one actor to influence the other is greater, the same or less than the other. In the program, power is established by randomly generated numbers for each set of expectations. If the power differential is exceeded, aggression occurs; if not, the actors are again frustrated, but proceed with establishing their intentions. If their intentions are very different, this represents the case when one has little invested in this goal and is willing to let the other do what he wishes, i.e., the former capitulates to the latter, but without additional increase in frustration. In this case, the two actors are ready to attempt to achieve the goal. If, however, their intentions are the same, they must strive to align their intentions so that they may proceed with attempts at goal achievement. In this part of the process, perceived instrumentality and rewards are decreased while costs and the level of frustration are increased. New intentions are recomputed and compared. This process continues until either their intentions are sufficiently different for one to capitulate so they may proceed or until the level of frustration of either actor exceeds his tolerance, in which case aggression occurs.

This process of goal achievement consists of computing row and column entries to a matrix of probabilities of success and then comparing that cell value with an independently established value representing the "required" level for success. Table 1 shows this matrix and the criteria for entry. The cell entries

represent probabilities of success. Thus, if the degree of difference in intentions is high and the degree of difficulty of the problem is low, the probability of success is very high (the 9 represents .9). Similarly, if the

TABLE 1. MATRIX OF GOAL ACHIEVEMENT

Degree of Difference in Intentions	Degree of Difficulty of Problem		
	Low	Moderate	High
High	9	8	7
Moderate	6	5	4
Low	3	2	1

difference in intentions is low and the difficulty of the problem is high, the probability of success is very low. Whatever probability value is selected, it is compared with a randomly generated value from zero to nine. If the former equals or exceeds the latter, the actors have successfully achieved their goal and proceed to reinforcement. If they fail, frustration is increased, instrumentality, rewards and costs are modified and they proceed to realign their intentions. This continues until they are again ready to attempt goal achievement or until the level of tolerance for frustration is exceeded.

The simplest process in this program is reinforcement. This consists merely of increasing perceived instrumentality and rewards by the amount which the probability of goal achievement exceeded the randomly generated value representing the required level necessary for success. Costs are decreased by this same amount. In addition, the amount of frustration is also decreased.

Finally, the aggression process is designed to approximate the results of the few research reports noted above. For example, when the program is shifted to the aggression process (which can occur in several ways), the level of frustration of each actor is tested to determine whether low, moderate or high aggression will occur. Low aggression consists of a modification of instrumentality, rewards and costs for both actors and a consequent re-establishment of intentions, i.e., the program shifts back out of the aggression process. If moderate aggression occurs (approximately 80% of the time, depending on the level of tolerance) the victim of the aggressive act capitulates (with an increase in frustration), i.e., his intentions become zero. The program then shifts to the attempts at goal attainment. Finally, under conditions of high aggression, the expectations of both actors become zero and the program stops. It should be noted again that these processes are integrated into the overall program and it is possible to shift from one to another depending on the values of the variables.

Results of Trial Runs

In this program, the variables which can be controlled by the researcher are perceived instrumentality, rewards, costs, required level of successful goal attainment and levels of tolerance for frustration. The "intervening" variable is the level or type of aggression that occurs, while the dependent variable is the resolution of intentions, e.g., which participant capitulates and for what reason. In this investigation, the trial runs were conducted under conditions of high, moderate and low levels of various combinations of the independent variables.

Each run consists of fifteen trials or fifteen sets of paired expectations. Although the independent variables are modified as the program proceeds, they are restored to their original assigned values before interacting with the next set of paired expectations. As a result, the fifteen trials can be compared with each other and the summary results of one run can be compared with the results of another run which had different values for the independent variable.

High Tolerance for Frustration

When the tolerance for frustration was high for both members, as might be expected, very little aggression occurred, regardless of the values of instrumentality. The only recorded instances of aggression were low, which probably occurred when an attempt at goal achievement failed, requiring the actors to realign their intentions with modified variables. Apparently, however, the second

attempts at goal achievement were always successful since no further aggression occurred. It is interesting to note that of the fifteen trials in the first run, only eight were resolved in favor of the more powerful actor and that in fact, resolution was made on the basis of stronger expectations, since instrumentality, rewards and costs were the same for both actors. Even though this would be expected because of the nature of the quasi-mathematical relationship, it is also theoretically feasible. That is, if both actors have a high tolerance for frustration, both have the same degree of perceived instrumentality, and the reward-cost differential is the same, it seems reasonable that the person who has the lowest expectations for outcomes of successful goal achievement would be the one who capitulates, i.e., gives up his intentions. It is likewise clear that these conditions are not useful for studying the effect of aggression, therefore, the remainder of the runs were made under conditions of low tolerance for frustration for one or both of the actors.

Low Tolerance for Frustration

When the tolerance for frustration of both participants was low, it was found that in the first five trials the amount of moderate aggression accounted for 85% of all the acts of aggression. After ten trials this had dropped to 78% and after all fifteen trials of this run, the percentage was only 66%. It should be recalled that field research data showed that about 80% of the cases of aggression were deliberate attempts to produce conformity

with the aggressor's expectations, that is, compliance-seeking behavior. On this run, the occurrence of moderate aggression (conceived as compliance-seeking behavior) is close to the findings of real data. The deviations noted in the last five trials are due primarily to the high level of frustration which had been accumulating over the whole run. As a result, there were several instances of high level aggression occurring which, of course, would dissolve the relationship. In addition, it was found that 80% of the time, intentions were resolved in favor of the more powerful actor, although the amount of difference in power did not matter appreciably. In two trials, however, the occurrence of moderate aggression on the part of the less powerful actor was enough to make the more powerful one capitulate. Furthermore, the actors successfully achieved their goal in the first seven trials, but failed thereafter. This resulted from an increase in high aggression which broke up the relationship before a new attempt on the goal could be made. The increasing frequency of high aggression, of course, was due to the increased frustration which had accumulated over the trials.

A second run was conducted, again under conditions of low tolerance for frustration for both members, but this time with a supposedly ideal condition of high perceived rewards and low costs. The results were somewhat surprising inasmuch as only on the first trial did the actors reach their goal successfully after Alter had capitulated to Ego who had slightly higher expectations and power. Even so, it required one act of low aggression and three

acts of moderate aggression before Alter capitulated. On the second trial, there was one act of moderate aggression on the part of Ego, but after Alter capitulated, they failed to reach the goal and Alter committed an act of high aggression against Ego and the relationship dissolved. For the remaining thirteen trials, the level of frustration rose so rapidly that only one act of high aggression occurred each time and this was enough to break the relationship. That aggression occurred early in the relationship was shown by the fact that the actors broke off the interaction before either had time to capitulate (their intentions were identical in each case) and no attempt was made to reach a goal (in each trial following the second, the probability of success and the required level were the same as the previous trial, indicating that new values had not been entered into those storage areas).

These results, while somewhat minimal, are still theoretically reasonable. It seems possible that when both actors perceive high rewards, but low costs in achieving a certain goal, that each would tend to maintain his position longer, that is, argue for his point of view. The result of this inability to align their intentions is increased frustration. Since a low tolerance for frustration was characteristic of both actors, one would expect that aggression would probably occur rather early in the relationship. As indicated above, the level of aggression that occurred was high, thus breaking up the relationship before the actors had a chance to agree on their intentions and attempt to

achieve the goal. Furthermore, while the power is an important variable, it is not always the predominant one. When the more powerful actor has either low expectations with respect to some goal or low perceived instrumentality, he may capitulate early in the relationship (without increasing his frustration) because he "doesn't care one way or the other," that is, he has a low investment in this particular relationship. In addition to this case, however, it was noted from the results that the less powerful actor may use a moderate level of aggression on the other actor even when their respective expectations and instrumentalities are high or at least equal. This occurs when the less powerful actor perceives the rewards as sufficiently high enough to risk punitive sanctions on the part of the more powerful actor. These results, of course, are also consistent with the theoretical framework.

High and Low Tolerance for Frustration

In the last series of runs, the two actors had different levels of tolerance for frustration; one was high, the other low. The trials from these runs show results similar to those indicated above. For example, in the six trials when the goal attempts were successful, intentions were resolved in favor of the less powerful actor five times, always after at least one instance of moderate aggression. Interestingly enough, in two of these trials, the aggression was committed by the actor with the higher tolerance for frustration. This, too, has some theoretical relevance. This is a situation when the less powerful individual (with the higher

tolerance for frustration) has the higher expectations and perceived instrumentality. Being unable to implement his intentions because he lacks the necessary power, he is continually frustrated until the point is reached where frustration exceeds tolerance and aggression occurs. In the nine trials when the goal was not successfully achieved, the less powerful actor committed aggression five times which resolved the intentions in his favor. Being unsuccessful, however, precipitated an act of high level aggression on the part of the more powerful actor, thus severing the relationship.

A final series of trials, again under conditions of low tolerance for frustration for one actor and high for the other, but with high rewards and costs showed that the goal was successfully achieved only once, on the first trial. In this case, intentions were resolved in favor of the less powerful actor on the basis of one act of moderate aggression. The less powerful actor also had the lower tolerance for frustration. In all the remaining trials, the actors were unable to make any attempt on the goal because they could not resolve their intentions before an act of high level aggression occurred to break up the relationship.

In summary, it can be said that these trials, conducted under varying levels of tolerance for frustration, instrumentality, rewards and costs, yield results that can be given a theoretical interpretation. It has also been noted that these results approximate the data collected in field studies. More importantly,

however, this study points to the considerable efficacy of tolerance for frustration, a variable which has received little experimental investigation. There is also an indication that the relative degree of power is less important than other variables in determining the outcome of interaction. In other words, this simulator program not only can reproduce results from field research, but also points to gaps in our knowledge which will require further research.

Conclusion

It is appropriate at this point to recall the criticism of simulation made by Professor Morison that what is needed is a type of program which would respond to "learning" type of questions with answers based on past experience and evidence. It was noted that Professor Wiener's reply was to the effect that this development is in the immediate future, but that at the present time, arbitrary controls are still needed in operating simulator programs.

It is felt that the simulator reported in this paper, while somewhat short of Morison's expectations, at least is a step in the right direction. It has demonstrated that programs can be written to reproduce results from field research and further, that based on these results, various situations which yield theoretically relevant data can be examined in detail. This program, then appears to have two main advantages; first, it permits utilization of the favorable characteristics of high-speed computers, that is, speed, accuracy, control of variables, etc. Second, and most

Importantly, it permits the researcher to test hypotheses deduced from theory.

It is clear that much remains to be done. As experimentation progresses and experience accumulates, it should be possible to design and carry out highly sophisticated simulator programs. It is equally clear that simulation is not supposed to replace field research, but to supplement it. The increased usefulness of simulators will depend upon technological improvements in development of computers, but also, especially for social scientists, upon the increasing accuracy and scope of social research in the field. In sum, computer simulation is a relatively new research tool and like questionnaire, psychometric examinations, etc., it has certain limitations, but also great potential for the advancement of knowledge in social science.

References

- Berelson, B. R., Lazarsfeld, P. F., and McPhee, W. N. Voting. Chicago: Univ. of Chicago Press, 1954.
- Blau, P. Theory of integration. Amer. J. Sociology, 1960, 65, pp. 545-56.
- Campbell, A. The voter decides. Evanston: Row, Peterson, 1954.
- Campbell, A., Converse, P. E., Miller, W. E., and Stokes, D. E. The American voter. New York: Wiley, 1960.
- Coleman, J. S. and Waldorf, F. Study of a voting system with a computer system. (Unpublished Ms., Johns Hopkins Univ., Baltimore, Md.), 1959.
- Conway, R. W., Johnson, B. M., and Maxwell, W. L. Some problems of digital systems simulation. Management Science, 1959, 6.
- Day, R. C. and Hamblin, R. L. Some effects of close and punitive styles of supervision. Tech. Rept. No. 8, Social Science Institute, Washington Univ., St. Louis, 1961.
- Dollard, J., Doob, L. W., Miller, N. E., Mowrer, O. H., and Sears, R. R. Frustration and aggression. New Haven: Yale Univ. Press, 1939.
- Greenberger, M. Simulation of a complex economic system. Proceedings of Second Operations Res. Internat'l Congress. (Aix-en-Provence, France), 1960.
- Gyr, J., Thatcher, J., and Allen, G. Computer simulation of a model of cognitive organization. Behav. Science, 7, pp. 111-116.
- Hamblin, R. L. The frustration-aggression hypothesis: a linear, log or power function? Tech. Rept. No. 13, Social Science Institute, Washington Univ., St. Louis, 1961.
- Hamblin, R. L. Aggression and the disruption of groups. (Unpublished Ms., Washington Univ., St. Louis), 1962a.
- Hamblin, R. L. The interference-aggression law? (Unpublished Ms., Washington Univ., St. Louis), 1962b.
- Harling, J. Simulation techniques in operations research--a review. Operations Res., 1958, 6, pp. 307-319.

- Heider, F. Psychology of interpersonal relations. New York: Wiley, 1958.
- Homans, G. C. Social behavior: its elementary forms. New York: Harcourt Brace, 1961.
- Lazarsfeld, P. F., Berelson, B. R., and Gaudet, H. The people's choice. New York: Duell, Sloan and Pearce, 1944.
- McPhee, W. N. and Smith, R. B. A model for analyzing voting systems. (unpublished Ms., Columbia Univ., New York, 1958).
- Newell, A. and Simon, H. A. The simulation of human thought. P-1734, Mathematics Division, The RAND Corporation, 1959.
- Orcutt, G. H., Greenberger, M., Korbel, J., and Rivlin, A. M. Micro-analysis of socioeconomic systems: a simulation study. New York: Harper, 1961.
- Saturday Review of Literature, April 7, 1962, pp. 46-49.
- Simmel, G. The sociology of Georg Simmel. H. Wolff (trans.,) Glencoe: Free Press, 1950.
- Thibaut, J. W. and Kelley, H. H. The social psychology of groups. New York: Wiley, 1959.
- Thibaut, J. W. and Riecken, H. W. Authoritarian status and the communication of aggression. Human Relations, 1955, 8, pp. 95-120.
- Vandenberg, S. G., Green, B. F., and Wrigley, C. F. A survey of computer usage in departments of psychology and sociology. Behav. Science, 1962, 7, pp. 108-110.
- Wilkins, E. J. and deCharms, R. Authoritarianism and power cues. Tech. Rept. No. 12, Social Science Institute, Washington Univ., St. Louis, 1961.